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Smartphone Internet access and use: Extending the digital divide and usage gap

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Abstract

This study uses survey data from the Pew Internet and American Life Project to advance digital divide research by exploring how smartphone dependence—in which one's only means of accessing the Internet is via a smartphone—and smartphone use differ between key demographic groups in the United States. Results show differences in smartphone dependence and use based on race, age, income, and education. Minority group members, younger, lower income, and less educated users are more likely to be smartphone-dependent. Additionally, minorities and younger individuals use smartphones for more social activity, while White, younger, and higher income individuals use smartphones for more news/information activity. Findings support the usage gap hypothesis and suggest smartphones may act as both a bridge and a barrier for disadvantaged groups to overcome the digital divide.

Keywords

device gap, digital divide, knowledge gap, mobile Internet, smartphones, usage gap

The digital divide, or the gap between so-called Internet haves and have-nots, has been a problem studied for at least two decades (U.S. Department of Commerce, National Telecommunications and Information Administration 1995, 2000; Norris, 2001; van Dijk, 2005, 2006). Although Internet penetration rates have increased substantially over time, approximately 25 million American households (21%) were estimated to have no regular Internet access at home or elsewhere like libraries or cafes during 2013 (Rainie

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& D'Vera, 2014). Additionally, only 67% of American households reported having broadband access in 2015, which represented a slight decrease of about 3% from 2013 (Horrigan & Duggan, 2015). According to a new Pew Research Center report (Pew Research Center, 2017), however, home broadband access rebounded to 73% of U.S. adults in 2016 highlighting the shifting nature of Internet access in America.

Scholars studying the implications of the digital divide have focused intently on two main levels of the divide (van Deursen & van Dijk, 2013; van Dijk, 2005). Level 1 involved motivation and access: Who has and does not have Internet access and why. As developed countries reached higher levels of Internet saturation, scholars began focusing on Level 2 of the divide—sometimes called the usage gap—in an attempt to identify how certain social groups use the Internet differently (DiMaggio, Hargittai, Celeste, & Shafer, 2004). Much of the recent digital divide research explores this usage gap (Buchi, Just, & Latzer, 2015; Mesch, 2012; Pearce & Rice, 2013; van Deursen & van Dijk, 2013, 2014; van Dijk, 2006; Wei, 2012; Wei & Hindman, 2011).

Usage gap research has yielded important insights into the digital divide; however, constant advances in Internet technology (e.g., Google fiber, gigabit Internet speeds, 5G mobile connectivity, smart watches) reinforce that how people access the Internet is still a salient issue in America, as well as in many other developed and developing countries. In fact, broadband Internet speeds and cost barriers to adoption are particularly relevant in the US, which reported below average Internet speeds and higher subscription rates than 12 of 24 countries measured among Organization for Economic Cooperation and Development (OECD) nations in 2010 (Mossberger, Tolbert, & Franko, 2012). With barriers to broadband adoption remaining high with substantial upfront investment costs, smartphones have become one of the fastest growing sources of Internet traffic (Cisco, 2016; Falaki, Lymberopoulos, Mahajan, Kandula, & Estrin, 2010).

There is a substantial smartphone-dependent population in the United States that relies exclusively on smartphones to access the Internet. An estimated 12% of adult Americans access the Internet only through their smartphones and have neither home broadband nor easily available access elsewhere like libraries or cafes (Smith, 2017). That represents a 4% increase compared to 2013 (Smith, 2015). Having one's Internet access limited to a smartphone has important implications for Internet use. As Napoli and Obar (2015) point out in their critique of the "emerging under-class" of smartphone-dependent Internet users, "Mobile Internet access represents an inferior form of Internet access on a number of fronts—content availability, platform and network openness, speed, memory, and interface functionality among other things" (p. 330). Relative to people who have Internet access on desktop or laptop personal computers (PCs), smartphone Internet users face greater barriers due to the technological limitations of smartphones and the smaller volume of content optimized for this technology (see Mossberger et al., 2012). It should be noted, however, that this does not mean smartphones are inferior in all contexts. For example, smartphone design makes the devices particularly portable due to their smaller size.

The present study applies the knowledge and usage gap hypotheses to examine how smartphone Internet access and use differ across demographic groups. This study advances previous research into digital divide Levels 1 and 2, specifically how gaps in Internet access and use are shaped by, and contribute to, inequality.

Literature review

Recent digital divide research has focused on whether access to and use of Internet technologies magnify or minimize inequalities related to information diffusion. This thread of research primarily focuses on the intersection of the knowledge gap and usage gap hypotheses to explore Level 2 of the digital divide (Bonfadelli, 2002). The knowledge gap hypothesis was first theorized as a way to better understand the disparities in how information spreads throughout a social system (Donohue, Tichenor, & Olien, 1975; Tichenor, Donohue, & Olien, 1970). The theory proposes that as information diffuses through print news media, higher socioeconomic status (SES) groups and advantaged populations tend to acquire more information at a faster rate than disadvantaged groups such that higher SES groups obtain information at a rate that makes the poor, poorer. Thus the gap in knowledge is exacerbated between these segments of the population (Tichenor et al., 1970). Access to information, or lack thereof, results in social inequality, conflict, and social control through the asymmetrical spread of information.

Foundational studies testing the knowledge gap focused on traditional news sources (e.g., print newspapers) as the key medium for transferring information to the public (Donohue et al., 1975; Ettema & Kline, 1977; Tichenor et al., 1970). More recent studies have applied the knowledge gap hypothesis to the Internet to identify and measure specific consequences of the digital divide. Wei and Hindman (2011) exposed a significant gap in political knowledge between low- and high-SES individuals, specifically for heavy Internet users. In their study, high-SES participants who used the Internet for greater levels of information scored significantly higher than low-SES participants on political knowledge. This was a wider gap than that seen for television, newspaper, and radio use.

Scholars have recently extended research on the knowledge gap to a usage gap between demographic groups (Lee & Yang, 2014). Whereas knowledge gap research generally focuses on differential information gains, scholars exploring the usage gap examine how different demographic characteristics impact use of the Internet for not only information consumption but social activities as well (Pearce & Rice, 2013; van Deursen & van Dijk, 2013). The Internet is not only a news source, but also an entertainment source and a social tool. In other words, what individuals choose to use the Internet for makes a difference in what they derive from that use. Usage skill is also an important aspect to consider in relation to the usage gap hypothesis (Hargittai & Hinnant, 2008; Zillien & Hargittai, 2009). For example, individuals with less education may lack skills needed to expand their social networks or to effectively search for news and information online. In sum, the usage gap provides a broader perspective on the impact of Internet use by considering how differences in use lead to different outcomes (van Deursen & van Dijk, 2013).

Device gaps and the digital divide

Level 1 of the digital divide began with a focus on who had access to basic Internet in the home. It then moved to who had access to broadband connections (DiMaggio et al., 2004; Norris, 2001; van Dijk, 2005, 2006). Today, with the diffusion of mobile Internet

devices, it is important to distinguish between who has access to the Internet on mobile devices, those who have broadband access, and individuals who have access to multiple devices. The current study explores this area of research taking Napoli and Obar's (2015) perspective that mobile Internet is inferior to broadband access; therefore, smartphone-dependent individuals (i.e., individuals limited to only a smartphone for Internet access) face a disadvantage in the forms of capital available through Internet access including social, economic, and political resources. From this perspective, smartphones are inferior because they have key disadvantages compared to devices such as laptops, desktops, and even tablets. For example, smartphone storage capacity is generally limited compared to the larger devices. Additionally, web-browsing speeds tend to be slower and less reliable on smartphone devices than laptops and desktops with a dedicated broadband connection (Napoli & Obar, 2015). Of course, inferiority depends on the task and there may not be a clear hierarchy to what device is most valuable. In fact, it may be that smartphones are most useful in coordination with other devices as they are useful in recording video or photos, but less so in photo and video editing.

With a few noteworthy exceptions (Chigona, Beukes, Vally, & Tanner, 2009; Donner, Gitau, & Marsden, 2011; Mossberger et al., 2012; Napoli & Obar, 2015), digital divide researchers have tended to focus on either who has access to the Internet or how different groups use the Internet. Whereas early research on Level 1 focused largely on access and examined demographic differences between Internet users and nonusers (Norris, 2001; Rogers, 2003; van Dijk, 2005, 2006), more recent research on Level 2 has considered the usage gap and evaluated differences in Internet use (Buchi et al., 2015; van Deursen & van Dijk, 2013, 2014; Zillien & Hargittai, 2009). Comparatively few studies, however, have integrated the two ideas to explore the implications of the devices used to access the Internet for the digital divide. The current project merges the larger trends in digital divide research and investigates access and usage gaps in the context of smartphone-dependent Internet users compared to multimodal Internet users (i.e., those who use mobile handheld devices as well as laptop or desktop devices to access the Internet). We sought to better understand who smartphone-dependent individuals are and how smartphones are being used by different groups. Such information will shed new light on the usage gap and how a possible device gap (i.e., disparities in types of devices individuals have access to) may be masking persistent inequality in both use and access.

Research examining smartphone Internet use is relatively limited, especially in the context of developed countries like the United States (for exceptions, see Chigona et al., 2009; Donner et al., 2011; Mossberger et al., 2012; Pearce & Rice, 2013). Yet, smartphones are becoming the fastest growing category of new Internet traffic (Cisco, 2016; Napoli & Obar, 2015). In fact, smartphone applications now account for 50% of all time spent on digital media by people in the United States (Lella, 2016). As Napoli and Obar (2015) point out, smartphone Internet access is a less rich experience than that of PCs. Several studies have highlighted deficiencies between smartphones and PCs. For example, one study found that memory and storage capacity limitations were frequently cited reasons for why smartphones cannot completely replace PCs (Hyde-Clark & van Tonder, 2011). Content issues are also a factor. Websites display differently on PCs compared to mobile devices, and just 52% of Fortune 500 companies run mobile optimized websites (Perez, 2015). Mobile users, therefore, have limited content viewing capabilities on their

smartphone devices compared to PC users. Such deficiencies can result in significantly different uses and outcomes across devices.

In an effort to contribute to research on Level 1 of the digital divide, we first focus on access and examine the demographic factors that distinguish smartphone dependents from multimodal users. We examine demographic differences between smartphone dependents whose Internet access is limited solely to a smartphone and multimodal Internet users who have Internet access on their smartphones along with other devices (e.g., tablet, laptop, etc.). Disadvantaged groups including minorities, older adults, women, lower income, and less educated individuals are typically less likely to have Internet access than their more advantaged counterparts (Jackson, Ervin, Gardner, & Schmitt, 2001; Jones, Johnson-Yale, Millermaier, & Perez, 2009; Lee, Park, & Hwang, 2015; Rogers, 2003; van Deursen & van Dijk, 2013). We expect these trends to extend to smartphone dependence.

Although smartphones still may be relatively costly, they are typically less so than a laptop or desktop PC especially because they are coupled with mobile Internet service. Laptop and desktop PCs, on the other hand, require the additional cost of a home broadband connection for Internet access (or an obsolete dial-up modem). The lower financial barriers associated with smartphones, therefore, make them more accessible to disadvantaged groups than PCs requiring a broadband connection. As such, we expect that traditionally disadvantaged groups are more likely to only have Internet access on their smartphone (i.e., smartphone dependents), whereas those groups who are traditionally advantaged may have Internet access on smartphones and other devices like laptop and desktop PCs connected to home broadband (i.e., multimodal Internet users). More specifically, we predict that smartphone dependents whose only Internet access point is their smartphone are more likely to be minorities, female, younger, have lower income, and less education.

> Hypothesis 1: Demographics including (a) race, (b) sex, (c) age, (d) income, and (e) education are associated with smartphone dependence. White, male, higher income, and higher educated individuals will have access to more devices while less advantaged groups including minorities, women, younger individuals, lower income, and less educated individuals will be more likely to be smartphone-dependent.

Whereas Hypothesis 1 considers those demographic groups who are more and less likely to be smartphone-dependent, Hypotheses 2 and 3 make predictions regarding demographic differences in Internet use on smartphones. The focus of these two hypotheses is not limited to smartphone dependents, but extends to all smartphone Internet users. Numerous usage gap studies investigating Level 2 of the digital divide have found general Internet use disparities based on demographic characteristics (Anderson, 2015; Buchi et al., 2015; Eastin, Cicchirillo, & Mabry, 2015; Pearce & Rice, 2013).

Other studies, however, have uncovered instances in which the traditional usage gap is reversed among disadvantaged minority groups (Gonzales, 2015; Mesch, 2012; Rains & Tsetsi, 2016). In these cases, disadvantaged groups report greater use of the Internet for social purposes than more traditionally advantaged groups. For example, Arab-Israelis reported using social network sites (SNSs) more frequently to expand their social

networks compared to the majority Israeli population (Mesch, 2012). SNSs are predominantly used for social activities such as meeting new people, contacting friends and acquaintances, and generally socializing with others (Brandtzæg & Heim, 2009; Cheung, Chiu, & Lee, 2011). Mesch (2012) argues that disadvantaged groups use the Internet to overcome social isolation and to expand their social groups while advantaged or majority groups use the Internet more for maintaining existing social ties (Mesch, 2012).

We predict that minorities, women, younger users, lower income, and less educated individuals will use smartphones for more social activities compared with advantaged groups as a way to compensate for social structural disadvantages. Social networks play an important role in both physical and economic well-being (Gonzales, 2015). Disadvantaged groups such as minorities and less educated individuals often face segregation from advantaged groups. This is exacerbated by limits on Internet access (Mesch, 2012). Smartphones, however, offer a chance to expand social networks and break out of physical boundaries through greater Internet access, which leads to relatively more social activity on the devices. On the other hand, advantaged groups are more likely to have sufficient existing social networks and will be relatively less motivated to use the Internet on their smartphones for social purposes.

> Hypothesis 2: Demographics including (a) race, (b) sex, (c) age, (d) income, and (e) education are associated with types of smartphone use such that minority groups, women, younger individuals, lower income, and less educated individuals, will use the devices for more social activities than Whites, men, older individuals, higher income, and higher educated individuals.

For news/information activities, a different trend is predicted. In studies conducted in developing countries, advantaged groups (i.e., males, Whites, higher educated, higher income) were more likely to use the Internet for activities such as information seeking and news consumption (Chigona et al., 2009; Donner et al., 2011). As previously noted, news/information activity is important because access to and use of such information are often connected to social status, Internet device limitations, as well as user skill (DiMaggio et al., 2004). The usage gap suggests that the way we use media has an impact on our social status (van Deursen & van Dijk, 2013; Zillien & Hargittai, 2009). Reading news, searching for health information, and visiting government websites would theoretically be beneficial to improving an individual's life chances because these activities can increase a user's knowledge of resources such as employment opportunities. This is important to consider because if this trend is the same for smartphone use, it will extend the knowledge and usage gap hypotheses to smartphone devices thus limiting their potential for bridging the digital divide.

We, therefore, predict advantaged demographic groups (i.e., Whites, men, older, higher income, and higher educated) will use smartphones for more news/information activities. This prediction is in line with previous usage gap studies focusing on Internet access via PCs (Buchi et al., 2015; van Deursen & van Dijk, 2013, 2014) and will provide additional insight into how demographic groups use smartphones. Unlike with social activities, advantaged groups use their smartphones more for news/information

activity that reflects and serves to reinforce their relative economic status. For example, prior studies found that socioeconomic status and education were significant predictors of commercial use of the Internet (Norris, 2001; van Dijk, 2005; Zillien & Hargittai, 2009). We expect the same trend with smartphones in which advantaged groups make greater use of the Internet on smartphones for news/information.

Hypothesis 3: Demographics including (a) race, (b) sex, (c) age, (d) income, and (e) education are associated with types of smartphone use such that White, male, younger Internet users, higher income, and higher educated individuals will use smartphones for a higher proportion of news/information activity.

Method

Sample

Data for this study were collected on behalf of the Pew Research Center's Internet Project (Pew Research Center, 2012). Interviews with a nationally representative sample of 2,254 adults were conducted between March 15 and April 3, 2012. Most of the interviews were conducted using landline telephones (n = 1,351) with the remainder conducted using cellphones (n = 903); both groups were included in the final sample. According to the Pew Research Center, the landline sample was collected using a proportional sample based on listed telephone households. The cellphone sample was selected systematically from dedicated wireless numbers. Topics covered in the interviews included Internet access, use, and perceptions of the importance of the Internet in respondents' lives. Random digit dialing was used to collect survey responses and the final sample was weighted to represent the American adult population. The sample response rate was 11%.

Respondents were slightly more likely to be female (n = 1,244, M = 55.2%) and, on average, were 52.4 years old (SD = 19.4). In terms of race, most respondents were White (n = 1,631, 72.4%), followed by Black or African American (n = 258, 11.4%), Hispanic (n = 211, 9.4%), Asian or Pacific Islander (n = 56, 2.5%), mixed race (n = 27, 1.2%), and Native American (n = 25, 1.1%). A total of 45 respondents (2%) either refused to answer this question or said they did not know and were excluded from analysis. One respondent identified as "other" and was included in the "all other" category of the dichotomous variable constructed for analyses (i.e., White and "all other"). More than half (54.2%) of the respondents reported an annual family income before taxes during the previous year of less than $75,000. Over one third of the respondents (36%) had completed college or greater education.

Measures

Device access. Responses to several items were used to construct the device access variable. Respondents were asked to report what Internet connected devices they own: desktop computer (n = 1,353, 60.3%), laptop computer (n = 1,293, 57.5%), smartphone (n = 904, 40%), handheld reading devices such as the Kindle or Nook (n = 400,

17.7%), and tablet computers (n = 393, 17.4%). Participants who indicated owning a mobile phone were asked whether their phone was a smartphone (n = 904, 40%) or not (n = 1,050, 46%).

Responses were recoded to create the device access variable. Respondents who reported having no Internet connected devices were coded as 0 (n = 401, 28%), smartphone-dependents who had access to the Internet on a smartphone but no other devices were coded as 1 (n = 55, 3.8%), and respondents who had multimodal access in the form of Internet access on a smartphone and at least one other device were coded as 2 (n = 977, 68.2%).[1] The no-access group was included because they represent a baseline from which to evaluate smartphone dependents and multimodal users.

Types of use. All respondents who reported using the Internet, sending e-mail, or downloading apps to their mobile phone (n = 1,124, 56.6%) were asked a series of questions about two general classes of Internet use activities specifically on their smartphone: news/information and social activities.

News/information activity. This measure was created using three items that capture the extent to which mobile phones were used to acquire distinct types of information, which have been associated with social status, as well as availability of economic resources (van Deursen & van Dijk, 2013). Respondents reported whether or not they used their mobile phone to: get news; look for health or medical information; and visit a local, state, or federal government website. Responses were coded as no (0), yes (1), and yes, I did this yesterday (2). Respondents who indicated that they did not know or gave no response were coded as missing. Mean scores were calculated for these three items; larger values indicate more frequent news/information activity (M = 0.77, SD = 0.60).

Social activities. Given that SNSs tend to be used to interact with others (Brandtzæg & Heim, 2009; Cheung et al., 2011), two items capturing respondents' use of SNSs were included to evaluate social activities. Respondents reported whether or not they used their mobile phone to: access a SNS like Facebook, LinkedIn, or Google Plus; and use Twitter. Responses were coded as no (0), yes (1), and yes, I did this yesterday (2). "Did not know" and nonresponses were coded as missing. A mean was computed for these two items; larger scores indicate more frequent social activity (M = 0.56, SD = 0.48).

Demographic characteristics. *Age* was evaluated as a continuous variable (M = 52.4, SD = 19.4) and *sex* was included as a dichotomous variable with male respondents coded as 0 (n = 1,010, 44.8%) and female respondents coded as 1 (n = 1,244, 55.2%). Education was measured by asking respondents to report the last grade or class they completed. Responses ranged from "none or grades 1–8/high school incomplete" (1) to "postgraduate training/professional school" (7). *Race* was evaluated as a dichotomous variable with White respondents (n = 1,631, 73.8%) coded as 0 and all other races (n = 578, 26.2%) coded as 1. *Income* was evaluated as a continuous variable. Respondents reported their household income during the last year in one of nine categories ranging from less than $10,000 (1) to more than $150,000 (9; M = 4.83, SD = 2.41).[2]

Data analysis

A chi-square analysis and univariate analyses of variance (ANOVA) were conducted to address Hypothesis 1. Multiple regression analyses were conducted to test Hypotheses 2 and 3. All analyses were conducted using the standardized weights created by the Pew Research Center.

Results

Demographic differences in device sophistication

Hypothesis 1 predicted smartphone dependence based on (a) race, (b) sex, (c) age, (d) income, and (e) education. As previously noted, respondents who did not use the Internet were included in the analyses to serve as a baseline. A chi-square test comparing nonusers, smartphone dependents, and multimodal users showed there was a significant difference between minority respondents and White respondents in their access to Internet connected devices $\chi^2(2) = 10.80$, $N = 1{,}507$, $p = .005$, $\phi = .085$. Whites were significantly less likely to be smartphone dependent and more likely to be multimodal than minorities.[3] H1a was supported. A second, chi-square test showed that women did not differ significantly from men in access to Internet connected devices, $\chi^2(2) = .40$, $N = 1{,}540$, $p > .05$. H1b was not supported. The frequencies for these analyses are reported in Table 1.

Univariate analysis of variance (ANOVA) tests were conducted to analyze the association between (c) age, (d) income, and (e) education with device sophistication. The results can be found in Table 2. The three device access groups significantly differed by age, $F(2, 1584) = 211.21$, $p < .001$, $\eta^2 = .21$. Tukey pairwise comparisons revealed that the no-access group was significantly older than the smartphone-dependent and multimodal groups. There was no significant difference between smartphone-dependent and multimodal groups based on age. This result was inconsistent with Hypothesis 1c.

There was also a significant difference in income across the three device access groups, $F(2, 1289) = 161.71$, $p < .001$, $\eta^2 = .20$. Tukey pairwise comparisons showed that individuals without access to the Internet and smartphone-dependent users reported significantly lower incomes than multimodal users. There was no difference between no-access and smartphone-dependent users on reported income. Hypothesis 1d was supported.

Finally, the three device access groups differed based on education, $F(2, 1568) = 187.86$, $p < .001$, $\eta^2 = .19$. Tukey pairwise comparisons showed that the education level of individuals without access to the Internet and smartphone-dependent users were significantly lower than those reported for multimodal users. There was no difference between no-access and smartphone-dependent users on reported income. Hypothesis 1e was also supported.

Demographic differences in smartphone use

Hypothesis 2 predicted that (a) race, (b) sex, (c) age, (d) income, and (e) education would be associated with types of smartphone use, such that minorities, women, younger, lower income, and less educated individuals would be more likely to use their smartphone for

Table 1. Frequencies of Internet device access based on race and sex.

	No access	Smartphone-dependent	Multimodal users
Race			
White	204 (21.4%, −2.0)	34 (3.6%, −2.3)	715 (75.0%, 2.7)
All other	144 (26.0%, 2.0)	34 (6.1%, 2.3)	376 (67.9%, −2.7)
Total	348 (23.1%)	68 (4.5%)	1091 (72.4%)
Sex			
Male	172 (22.7%, −.4)	38 (5.0%, .5)	548 (72.3%, .2)
Female	185 (23.7%, .4)	35 (4.5%, −.5)	562 (71.9%, −.2)
Total	357 (23.2%)	73 (4.7%)	1,110 (72.1%)

Note. Numbers in parentheses are percentages (rows) of the total that comprises each category along with adjusted standardized residuals: Residuals ±1.96 indicate a significant departure from expected values. Total frequencies are based on weighted data.

Table 2. Internet device access based on age, income, and education.

	No Internet access *M* (*SD*)	Smartphone- dependent *M* (*SD*)	Multimodal *M* (*SD*)
Age	58.56 (18.83)$_a$	40.48 (18.33)$_b$	38.55 (18.16)$_b$
Income	2.81 (1.75)$_a$	3.03 (2.02)$_a$	5.52 (2.38)$_c$
Education	2.99 (1.48)$_a$	3.23 (1.45)$_a$	4.76 (1.60)$_c$

Note. Means that do not share subscripts are significantly different ($p < .05$, Tukey comparison).

social activities. To reiterate, these analyses were not restricted to smartphone dependents, but involved all respondents who reported owning a smartphone. All predictor variables were entered in the same block of a regression model with social activities serving as the outcome variable. The model with the five demographic factors included, predicted significant variance in the amount of social activities respondents performed on their smartphones, $F(5, 952) = 13.93$, $p < .001$, $R^2 = .06$. The results can be found in Table 3.

Race was a significant predictor of smartphone social activity, with minorities being significantly more likely to conduct social activities on smartphones than Whites. H2a was supported. Age also significantly predicted social activity. Younger smartphone users were significantly more likely to conduct social activity on their mobile devices. H2c was supported. Sex, income, and education were not statistically significant predictors of social activity on smartphones. H2b, H2d, and H2e were not supported. In sum, H2 had mixed support. Minorities and younger Internet users performed significantly more social activities on their smartphone devices than Whites and older individuals.

H3 predicted that (a) race, (b) sex, (c) age, (d) income, and (e) education would be associated with types of smartphone use such that White, male, older, higher earning, and higher educated individuals would use smartphones more frequently for news/information activities. All predictor variables were entered in the same block of the regression

Table 3. Results of the regression models for Internet activity.

	Activity type							
	Social				News/information			
	β	t	$r^2_{partial}$	p	β	t	$r^2_{partial}$	p
Race	.081	2.47	.006	.014	−.06	−1.91	.004	.057
Sex	−.04	−.71	< .001	.434	.011	.33	< .001	.741
Age	−.24	−7.145	.05	< .001	−.14	−4.16	.02	< .001
Income	.004	.104	< .001	.917	.08	2.00	.004	.046
Education	−.007	−.209	< .001	.835	.04	1.17	.001	.242

Note. For the race variable, Whites were coded 0 and "all other" were coded 1. For sex, men were coded 0 and women were coded 1.

model and news/information activities served as the outcome variable. The five demographic variables explained significant variance in the amount of news/information activities respondents performed on their smartphones, $F(5, 952) = 5.10$, $p < .001$, $R^2 = .03$. The results are reported in Table 3.

Whites performed marginally more news/information activity on their smartphones compared to minorities. Although these results were consistent with H3a, they did not reach the conventional criterion for statistical significance. Age significantly predicted news/information activity. Younger smartphone users were more likely to conduct news/information activities on their smartphones. H3c was supported. Income also significantly predicted news/information activity. Higher income individuals conducted more news/information activities on their smartphones. H3d was supported. Sex and education both failed to predict news/information activity. H3b and H3e were not supported. In sum, mixed support was found for H3. White, younger, and higher income individuals performed more news/information activities on their smartphones.

Discussion

This study makes important contributions to digital divide research by focusing specifically on smartphone dependence and use. It offers new observations regarding the knowledge and usage gap frameworks in the context of smartphones using a national sample of U.S. adults. The key findings and their implications will be discussed in the following paragraphs.

Device access

First, the results from this project illustrate the continued existence of Internet access gaps between key demographic groups despite the progress that has been made in addressing Level 1 of the digital divide. Minorities, less educated, and lower income groups were more likely to be smartphone dependent than White, more educated, and higher income groups who were more likely to be multimodal users (i.e., had access to

the Internet on smartphone and at least one other device). Notably, minority users were significantly more likely to be smartphone dependent and less likely to be multimodal users. Also important to note is that there was no significant difference between the no-access group and the smartphone-dependent group regarding income or education. This pattern of findings lends support to the concept of a *device divide* between the traditional Internet haves and have-nots. That is, even when people who are traditionally disadvantaged have Internet access, their access often comes in the form of fewer and more limited devices compared to those who are more advantaged. This finding illustrates the concept of the Matthew Effect in which the rich get richer at a rate that makes the poor, poorer (Merton, 1968). The persistent access gap exposed in this study stemming from socioeconomic factors of income and education has important implications for the digital divide.

On the one hand, studies have pointed out that the spread of mobile connectivity is beneficial for disadvantaged groups because it provides these individuals with their only viable access point to the Internet. Smartphones can, therefore, provide disadvantaged individuals with greater social, economic, and political opportunity (Chigona et al., 2009). On the other hand, devices inherently have different technological capabilities that make them more or less useful (Napoli & Obar, 2015). Smartphone access is a less rich, less dynamic, form of access than broadband laptop or desktop PC access. Factors such as memory, storage capacity, speed, and network architecture have all been cited as deficiencies of smartphone devices (Napoli & Obar, 2015). Together, these factors can limit online activities such as searching and applying for jobs, which requires document sharing, word processing, and interface compatibility among other capabilities.

Smartphone use

This study shows that demographics were associated with types of smartphone use. Again, the analysis of smartphone use was not limited to smartphone dependents and included all participants who owned a smartphone with Internet access. Race provided a particularly powerful juxtaposition in smartphone Internet use. Specifically, minorities performed significantly more social activity on their smartphones than Whites. Whites, on the other hand, performed marginally more news/information activity on their smartphones. This finding coincides with prior studies that argued minorities and disadvantaged populations use the Internet for social outreach in order to expand and improve their social capital (Gonzales, 2015; Mesch, 2012). The implications of this type of use are that minority groups are using the devices in order to break out of societally imposed boundaries. Another possibility, however, is that the increased social activity performed by minorities could actually be perpetuating a knowledge gap by distracting these users from news and information activities. In other words, if users are spending more time conducting social activities, they have less time to spend obtaining news and information.

Results of this study also show that income continues to be a significant predictor of Internet use (Buchi et al., 2015; Madden & Rainie, 2003). Lower income individuals reported less news/information activity on their smartphone devices than higher income groups. This finding supports the basic tenets of the usage gap hypothesis. The implication is that underlying inequality in access to devices is an important factor that can alter

the way individuals perceive and use smartphone devices, which in turn has the potential to improve their social, political, and economic resources.

The most robust findings regarded age differences in access and use. Younger people accessed more devices and used smartphone devices significantly more frequently for social activity and news/information activity, which coincides with findings that older individuals are generally less likely to perform online activities such as using e-mail, using search engines, and reading online news (Pearce & Rice, 2013; Wei, 2012).

Prior studies found that men and women use the Internet for distinctly different purposes. For example, men used the Internet more for commercial research and news reading than women (Jones et al., 2009). Other studies have found that women actually use the Internet for more social interaction than men (Wasserman & Richmond-Abbott, 2005) and that women are more likely to use their smartphones (Findahl, 2013). The current study, however, showed that there was no significant difference between the sexes in social *or* news/information activity. The implication is that the gap in use based on sex may not fully extend to smartphone users in the United States. Education, which has been a key factor in the usage gap, also did not impact activities. This suggests that smartphones may be leveling the playing field when it comes to traditional use disparities between both sex and education demographics.

In considering the findings related to smartphone use, it should be noted that the effect sizes for the statistical tests were modest. This may be an artifact of using secondary data and adapting existing items to test our hypotheses. Nonetheless, the findings from this study—taken as a whole—offer a fuller perspective of the digital divide in relation to smartphones. Access itself continues to be an issue among lower income and less educated individuals who are more likely to be smartphone-dependent. When coupled with use findings, the access gap reveals even more. Lower income individuals, in addition to being more dependent on their smartphones, performed less news and information activity on their devices and an equal amount of social activity compared to upper income individuals. The implication is that for lower income individuals, smartphone devices are not helping overcome the digital divide and may even be widening it by giving upper income people more tools to expand the gap. This finding supports the usage gap and the basic tenets of the knowledge gap hypothesis, which states that the asymmetrical spread of information leads to social inequality. So this device gap (e.g., lower income individuals more likely to be smartphone dependent) actually masks inequality by providing a limited form of Internet access that is often not distinguished from other, richer forms of Internet access such as broadband connectivity and multimodal access. On the other hand, the results suggest that smartphones can act as a bridge for minorities who use smartphones for more social activities than Whites, which could increase this traditionally disadvantaged group's social capital.

Limitations and future directions

Smartphone-dependent users are a particularly difficult population to sample. Indeed, only about 2.4% of respondents in this study were smartphone dependents. Data for this study were collected during 2012. Since that time, smartphone adoption in the United States has increased fairly dramatically from about 35% in 2011 to about 77% in 2016

(Smith, 2017). Although a larger and more recent sample of smartphone users may result in a larger number of smartphone dependents, it is important to note that the data analyzed in this project were part of a national sample of adults surveyed by the Pew Research Center. There is reason to believe that the smartphone dependents and users examined in this study were representative of these broader groups in the United States at the time of data collection. A second limitation stems from our use of secondary data. It would be desirable to have more nuanced items to measure social and information Internet activities.

Moving forward, these findings need to be tested in an experimental setting in order to better identify key differences between smartphone, tablet, and PC devices. It would be valuable to directly compare the effects of smartphone Internet access relative to multimodal Internet access on social and information activities. Additionally, the concept of affordances could offer further insight into why different demographic groups choose to use smartphones for specific activities (Gibson, 1986). The concept of affordances has been used to study social media (Treem & Leonardi, 2012) as well as Internet use generally (Rainie & Wellman, 2012; Wellman, Haase, Witte, & Hampton, 2001). Determining if different demographic groups perceive different affordances for smartphones would offer an additional explanation for the usage gap. Finally, understanding differences between smartphone-dependent and multimodal users in terms of content creation and dissemination is another area of future research that should be explored.

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Notes

1. Laptop/desktop-only users (n = 711, 31.6%) were excluded from analysis.
2. Approximately 21% or 477 respondents declined to answer this question.
3. While we have chosen to compare Whites with all other minority groups taken together, there is evidence in the digital divide literature suggesting that minority groups also differ significantly in their smartphone dependency.

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